

REMARKS/ARGUMENTS

The Office Action of March 22, 2005 has been reviewed and considered. In the Office Action, claims 1, 3-20 were rejected under 35 U.S.C. §102. Claims 15-19 were also rejected under 35 U.S.C. §112, second paragraph.

Claims 1 and 3-20 have been canceled and new claims 21-42 have been added. Reconsideration of the application is requested.

Claim 21 corresponds to canceled claim 1. Dependent claims 22-28 correspond to canceled claims 4-10. Claim 29 corresponds to canceled claims 1 and 3 combined. Dependent claims 30-31 correspond to canceled claims 18 and 20. Claim 32 corresponds to canceled claim 1 without the thermal coefficient recitations. Dependent claims 33-34 correspond to canceled claims 5 and 8. Claim 35 corresponds to canceled claims 1 and 3 combined without the thermal coefficient recitations. Dependent claims 36-37 correspond to canceled claims 18 and 20. Claim 38 corresponds to canceled claim 11. Dependent claims 39-41 correspond to canceled claims 12-14. Claim 42 corresponds to canceled claim 11 without the thermal coefficient recitations.

Claims 15-19 were rejected under 35 U.S.C. §112, second paragraph, as being indefinite. Claims 15-19 are canceled and thus the rejection is moot.

The instant claims all require a second carbon layer *consisting of* nanocrystalline diamond. Page 4 of the instant application, third paragraph, references a document describing the generation of nanocrystalline diamond films. Page 16, third paragraph, provides more details including the Raman spectrum of nanocrystalline diamond.

At the time the instant application was filed, the terms "nanocrystalline materials" were understood by the skilled person to mean grain sizes in the range below 100 nm. The attached Information Disclosure Statement lists four documents that support this accepted definition nanodiamond or nanocrystalline.

For example: Nanomaterials: Synthesis, Properties and Applications Edited by A.S. Edelstein et al 1996 Institute of Physics Publishing, Bristol and Philadelphia ISBN 0-7503.0358-1.

In this book, we use the conventional definition of nanomaterial as material having a characteristic length scale less than about a hundred nanometers. This length scale could be a particle diameter, grain size, layer thickness, or width of a conducting line on an electronic chip.

To those of skill in the art at the time of filing, "nanophase material" meant phases in the range below 100 nm, and typically from 1-100 nm. The term "nanophase" is generic. When the nanophase is crystalline, the terms "nanocrystalline" or "nanograined" are used.

The documents further demonstrate that the material characteristics change significantly during transition to nanophase size. For example, page xiii of *Nanophase Materials: 1994*, Kluwer Academic Publishers:

The atomic scale structures of nanophase materials play a dominant role in determining their properties.

Page 233 of this same document refers to the significant differences in the mechanical characteristic and page 423 describes that decreasing the crystal size to the nano-regime increases the thermal conductivity. Page 488 describes "nanograined diamond films" (e.g. "nanocrystalline diamond") and that optical features are changed severely, if one starts from nanograined material towards conventional material.

Ullmann's Encyclopedia of Industrial Chemistry by Wiley-VCH Verlag GmbH & Co. KGaA 2000 provides: (Note copy of this document was not provided to the undersigned.)

1. Introduction

... Materials with fine-scale structures have long been recognized to exhibit remarkable and technologically attractive properties. Interest has been growing in a new class of ultrafine-grained materials, called nanocrystalline, nanophase, or nanostructured materials (*n*-materials) [1-3], wherein the particle or grain size is 1 - 100 nm. This interest stems not only from the outstanding properties that can be obtained from such materials, but also from the realization that early skepticism about the ability to produce high-quality nanoscale powders at a competitive cost was unfounded. ...

2. Characteristics of Nanostructured Materials

.... A feature of nanoscale materials is the high fraction of atoms that reside at particle surfaces or grain boundaries. Figure 2 shows a plot of volume fraction of atoms that reside at the grain boundaries of a nanoscale material with decreasing

grain size [5]. At a grain size of less than 20 nm, as much as 30 % of the atoms can be present at the grain boundaries. Accordingly, the interfaces play a crucial role in determining the mechanical, optical, and electrical properties of the material.

In general, nanoscale materials exhibit dramatic changes in properties, such as enhanced sinterability at low temperatures [6], [7], improved UV scattering [8], very high hardness and wear resistance [9] [10], enhanced gas sensitivity, [11], smaller particle size in colloidal suspensions, superior magnetic and dielectric strength, and enhanced optoelectronic properties [12]. Table (1) lists some of the unique characteristics of nanomaterials and the corresponding grain/particle size effects.

In general the features of nanophase materials do not come from simple reduction of crystal size as described by Zimmer, for example. Zimmer uses small size crystals to obtain a smoother surface. The multilayer can also stop with coarse grained crystals. This is different from the current application. The material characteristics of the second layer of the instant claims changes because there is a high percentage of carbon atoms present at the grain boundary of the diamond grain.

None of the prior art cited in the rejections teach or suggest the claimed nanocrystalline layer, i.e. a layer *consisting of* nanocrystalline diamonds – having a grain size below 100 nm.

Claims 1-3, 5-8, 11-20 have been rejected under 35 U.S.C. §102(e) as being anticipated by U.S. Patent No. 6,063,149 to Zimmer.

Zimmer does not teach or suggest a nanocrystalline diamond layer. The only reference to grain size is provided at column 3, line 49, for the outer surface of the coating where the smallest particles are present. Zimmer states that "average grain size is substantially less than three microns." 3 microns is 3000 nm. This is an average grain size; an average is taken from both larger and smaller particle sizes.

In contrast, nanocrystalline diamond has a grain size of below about 100 nm or about 1-100 nm. There is more than an order of magnitude between 3 microns (3000 nm) and 100 nm. Based on the description and figures in Zimmer, one skilled in the art would not consider a grain size of "substantially less than three microns" to be a teaching that all of the grains have sizes

below about 100 nm. Zimmer simply does not teach applying a "second" carbon layer *consisting* of nano-crystalline diamond or that the second layer is a separate layer..

In addition, Zimmer does not show any abrupt change of properties between diamond layers, but instead provides a "graded" layer transitioning smoothly from coarse to fine grains. See Figure 2 which demonstrates how the second layer containing smaller particles fill in between the voids of the first layer containing larger particles – providing the smooth transition. This transition has *no* clear *distinction* between layers, but instead, is continuous.

The controlled process conditions in Zimmer are intended to produce polycrystalline coatings having progressively finer grain size in the direction of the outer surface. Therefore, the diamond coating disclosed in the patent to Zimmer is quite different from the diamond coating recited in the instant claims.

Zimmer clearly fails to disclose a second layer *consisting* of nano-crystalline diamond. As is well settled, a publication cannot anticipate a claim if it does not teach each and every element recited in the pending claim. Therefore, the patent cannot anticipate the pending claims because it fails to teach all that is recited in the pending claims. Withdrawal of the rejection is requested.

Claims 1-9 and 11-20 have been rejected under 35 U.S.C. §102(e) as being anticipated by EPO Publication No. EP 0 596 619 to Crystallume.

Crystallume does not discuss crystalline size and therefore does not teach or suggest nanocrystalline diamond. In addition, Crystallume does not disclose differences between layers A and B or that B contains less diamond.

Although Crystallume describes different process conditions for the layers, there is no indication that the second layer contains less diamond or has a higher coefficient of thermal expansion. In fact, based on the examples, it is more likely that the first layer would contain less diamond. In the first example, the first layer comprises additional boron (diborane gas added), so it will tend to comprise less diamond, not more. In the second example, the first layer is deposited using higher CH₄ so that it will also tend to comprise less diamond (because of smaller

grain size), not more. Thus one skilled in the art would not utilize less diamond in the second layer based on Crystallume.

Crystallume does not teach or suggest the nanocrystalline diamond or the differences in the first and second layer as required by the instant claims. Therefore Crystallume cannot anticipate the pending claims. Withdrawal of the rejection is requested.

Claims 1, 2 (sic) -20 have been rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 6,066,339 to Hirano or U.S. Patent No. 5,942,317 to White.

Hirano does not disclose a coated tool for machining. Instead the substrate is a "sliding part" (see, column 14, line 30.) In addition, Hirano does not teach diamond grain sizes and does not teach nanocrystalline diamond. Moreover, in every example, Hirano teaches providing a first layer directly on the substrate with less diamond (higher SP2/SP3 ratio). This teaches away from applying a first layer with higher diamond (lower SP2/SP3 ratio).

Moreover, Hirano discloses films having a maximum thickness of 2500 Å (250 nm), whereas dependent claims 26, 31, 34, and 37 recite a minimum thickness of only layer B of 500 nm (0.5 µm).

White is directed to *amorphous* hydrogenated carbon (C:H) and does not teach crystalline diamond. Moreover, White is directed to a magnetic disc not a coated tool.

As is well settled, a publication cannot anticipate a claim if it does not teach each and every element recited in the pending claim. Therefore, each of Hirano and White fails to disclose the above-discussed recitations of the pending claims, and each cannot anticipate the claims. Hence, withdrawal of the rejections is requested.

CONCLUSION

For all of the above-discussed reasons, Applicants respectfully submit that claims 41-36 are allowable and that the application is now in condition for allowance. A notice to this effect is earnestly solicited.

Appln. No.: 09/937,897
Amendment dated June 24, 2005
Reply to Office Action of March 22, 2005


If any questions or issues remain, the resolution of which the Examiner feels would be advanced by a conference with Applicants' attorney, the Examiner is invited to contact Applicants' attorney at the number noted below.

If any fees are required with this submission, the Commissioner is authorized to charge such fees to deposit account No. 19-0733.

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